

ARMY AVIATION NEEDS HIM NOW—WHERE'S BILLY MITCHELL?

BY

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ABSTRACT

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ARMY AVIATION NEEDS HIM NOW—WHERE’S BILLY MITCHELL?

Introduction and Problem Statement

A United States Air Force C-5A Galaxy sat at the end of the runway, its crew completing their checklists and waiting for clearance to depart Dover Air Force Base on what was to be their third trip overseas in a month. On board were members of 1st Attack Reconnaissance Battalion, 82nd Airborne Division, en route to Balad Air Base, Iraq, to support Operation Iraqi Freedom (OIF). For most of the soldiers on board, it was their second or third deployment. For many, though, it was their first deployment and even their first time flying on the behemoth aircraft they had, only hours before, loaded with four of their Apache AH-64D helicopters for the transatlantic flight. Having received their passenger instructions from the load master, the soldiers prepared for their long flight. Hearing the engines run up for take off, they knew they would soon feel the aircraft begin its takeoff roll and would be airborne in only a matter of seconds. Following a normal takeoff and initial climb, the C-5 aircrew observed a No. 2 engine “Thrust Reverser Not Locked” indication light. They shut down the No. 2 engine as a precaution and returned to Dover AFB.

The Vice Chief of Staff of the Army, an aviator himself, was returning from an update on the current situation in Iraq. Turning down the Army corridor, he quickly found his office. Settling in behind his desk, he saw that Fox News had just cut away to a news flash. Televised was a behemoth C-5 aircraft, the Air Force’s largest cargo aircraft, broken, twisted and burning in the background behind the reporter. Grabbing the remote he turned the volume up and confirmed his fears, a C-5 was down just outside of Dover Air Force Base, one of the major departure points for Army equipment going into theater. As the camera panned back at the broken aircraft, however, he caught a glimpse of one of his worst fears, the unmistakable nose of an AH-64 Attack Helicopter, one of four aboard, disappearing behind a wall of flames.

Hearing the General’s request, his aide-de-camp quickly dialed the number for the AH-64 Apache Program Manager (PM) from memory. The vice chief’s question was simple: “Where do we get the replacement aircraft from?” The PM knew the answer wasn’t a simple one.

Historical Background and Analysis

Aviation Industry (World War I): What would constitute overwhelming superiority in the air?¹

When the Signal Corps first toyed with its 1917 order for aircraft, it was unimaginable that by July the number would climb to a total of 22,000 aircraft.² The Joint Army and Navy Technical Board established the number of aircraft required as follows: Training (7,050), Defense of the United States (725), and for use in France (12,000).³ Three thousand additional aircraft were designated as training aircraft for foreign aviators. With a large American ego and little understanding of the industry required to support this type of endeavor, the board also established a timeline of 12 months for delivery. Having shortly realized their failing to account for spare parts, the number of aircraft and spares required quickly grew to the equivalent of 40,000 aircraft.⁴ When you consider that in the previous year the United States aircraft manufacturers had only produced 800 aircraft, the next year was to be a daunting one.

In July 1917, Congress appropriated its largest amount ever to support the rapid growth called forth by the joint board. Totaling a combined value of nearly \$651M, it was a mammoth undertaking to bring the United States on par with its adversaries.⁵ At the time this bill was signed by the President, the United States had an air power which totaled 224 aircraft.⁶ However, even those small numbers of aircraft coming off the production lines in the US were obsolete on delivery as compared to their contemporaries flying in the skies of Europe. The United States needed to produce aircraft fast, with no industrial base to support its requirement.

Beginning as early as April 1917, the War Department began researching what was required to produce relevant military aircraft in America. The United States immediately dispatched “a commission of six civilian and military experts, headed by Maj. R. C. Bolling” to Europe.⁷ Upon their return, an urgent request for assistance from the Chief of the Signal Corps to France, England, and Italy for experts to be sent to the United States was issued. Based on the experts’ analysis and the Bolling mission report, it became evident how woefully unprepared the US industrial complex was. Additionally, the United States had not even begun to realize the enormous material requirements for wood, sheet steel, wire, cloth, and varnish to build even a fraction of the desired aircraft. As a result, an immediate order was placed with French companies for 5,875 planes, which were to be delivered by July 1st of 1918.⁸ The need for

engines to power these great machines would, while the United States possessed a great automobile engine manufacturing capability, be nearly as difficult to acquire as some of the raw material.

The average aircraft of the era required 500 feet of lumber to manufacture, and this wood, “in the hands of skilled cutters” can be cut from “1,000 feet of rough lumber.”⁹ However, in the early days of manufacture, it was taking as many as 5,000 feet of spruce “because of imperfections in the lumber, lack of proper inspection at the mills, and faulty handling in transit and in the factories.”¹⁰ While spruce and fir, the two predominantly used woods, were plentiful in the Pacific Northwest, so were labor issues. As a result of these disputes and the isolated locations of many of the greatest concentrations of these trees, the effort was handed over to COL Brice P. Disque and the Spruce Production Division of the Signal Corps.¹¹ Prior to this organization being transferred to the Bureau of Aircraft Production, COL Disque had been able to resolve all the labor disputes, lay in rail lines to move the harvest, coordinate for funding to upgrade the mills to meet the strict manufacturing requirements, and establish training courses to ensure the stringent requirements were understood and implemented correctly. As a result, more than 180,000,000 board feet of this critical aircraft component were harvested from the Northwest.¹²

While England had assured the United States that it could “provide all of the linen that would be needed”¹³, it became painfully clear that was not the case. As a result of the woeful capacity of the Irish linen manufacturing capability, the US began looking at cotton cloth to cover the wings of the equivalent 40,000 required aircraft. Because of uniformity issues when using existing dope—the chemical applied to stretch the cloth and make it non-porous and smooth—on cotton cloth, a new dope was needed. While estimates for American 1918 requirements were around 25,000 tons, the British requirements took up the entire world’s supply.¹⁴ US response was to increase production through the establishment of multiple chemical plants. Following the commandeering of all existing American supplies of acetate of lime, the primary ingredient of the new dope, the United States and England entered into a pool with the allies to disperse the remaining product based on urgency of need.¹⁵ As a result of the increased productivity of the new plants, and the agreements made, the United States was able to

produce more than 1.3 million gallons of fabric dope without “upsetting any of the European war-production projects.”¹⁶

In World War I, an aircraft engine weighed roughly one quarter the weight of an automobile engine while producing the same horsepower. Realizing the one great American industrial capability was automobile engine design and manufacture, the decision was made to produce the required aircraft engines in the United States. This task became the responsibility of the Equipment Division of the Signal Corps. Based on their analysis of European engine design and manufacturing, they determined that the United States must design and produce its own engine rather than tool up for an engine that would be outdated by the time the first one found itself installed in an aircraft. However, their decision was primarily based on the fact that allied European nations were producing as many as 83 different types of aircraft engines, and logistics had become a nightmare.¹⁷ The answer was evident. By limiting the number of engines manufactured, the United States could concentrate on designing a superior engine, rapidly tool the industry for its manufacture, and train the workforce to produce them.

The design and manufacture of this engine, while seemingly simple, was a relatively complex problem. In an effort to produce an engine that would meet the suggested requirements (weight/horsepower) as established in agreement between the Allied powers, it was decided that two engines would be produced. The first, an eight- cylinder, would produce 225 horsepower; the second, a 12-cylinder, would produce 330 horsepower.¹⁸ Key to this decision was that they would use the identical parts, where permitted, thereby limiting the logistical footprint. A mere five months passed until the first engine was delivered. In all, 100,993 engines were placed on order by the Aircraft Production Board for production by six automobile and specialty manufacturers.¹⁹ By war’s end, the eight-cylinder engine was deemed outdated and limited in production to less than 8,000, while the 12-cylinder, aptly named the Liberty Engine, had seen improvements to 400 horsepower, with production numbers greater than 15,000.²⁰

While the engine manufacturing volume of the United States had surpassed the combined capabilities of France and England in less than one year, it was not without problems. As with the spruce industry, there were problems with standardization of training and establishing manufacturing standards. As the design of the 12-cylinder engine continued toward 400 horsepower, the tooling, originally designed for just 330 horsepower, had to be scrapped.

Additionally, the metals required became more stringently controlled to ensure the engine's ability to withstand the large increases in stress. Engine manufacturing was not without its labor issues as well. In some cases, as much as 85% of the tooling being shipped to the manufacturers was found to be defective or out of specifications.²¹ In others, direct sabotage by German sympathizers was evidenced by attempts to plant explosives in coal shipments as well as the theft or damage of tooling and parts in the factories.²² In the end however, the United States Standard 12-Cylinder Engine delivered what was promised - liberty.

To manufacture the required training aircraft, the Aircraft Production Board again turned to the automobile industry since existing aviation manufacturers were "quite insufficient".²³ In addition to the five existing Army aircraft manufacturers and five Navy aircraft manufactures, the Fisher Body Company (then the largest manufacturer of automobile bodies), the Dayton-Wright Airplane Corporation and two other new manufactures were contracted to supplement the manufacture of the required training aircraft. An additional seven companies were contracted for spares during the course of the following year. US industrial might responded, and manufacturing reached a peak at the Curtiss Company in March of 1918 when 756 aircraft were produced. By war's end, 8,567 of the required 10,050 training aircraft were produced.²⁴

Following General Pershing's direction to not attempt to produce any single-seat fighters the focus shifted to the design and manufacture of two-seat observation aircraft. Initially, this included the modification of foreign aircraft such as the De Havilland D-4. While incorporating weapons, instruments, and the Liberty engine was a difficult task, the endeavor took a mere three months once the British-built aircraft arrived in the United States. While modifications to the nearly 5,000 D-4s were a success, the attempt to modify a Bristol aircraft to the Liberty engine was a complete failure. It became evident that modifying existing European manufactured aircraft for our equipment was less than ideal and in many cases futile. With the assistance of a French engineer, the first aircraft built around the Liberty engine was designed, manufactured and tested. Other manufacturers had great success; for example, Thomas-Morse produced the fastest airplane yet tested.

When the armistice was signed in November 1918, American aircraft design and production capabilities were just beginning to be seen. Throughout the conflict, the War Department saw "No Reason for Discouragement"²⁵ and many believe if the war had continued

the United States would have easily exceeded the Europeans' capabilities as aircraft designers and manufacturers. One such proponent was Brigadier General William "Billy" Mitchell. In 1919, following a review of all the "latest types of American planes and aerial equipment,"²⁶ he sent the following to the Director of Air Service, Washington, DC:

"I recommend the following airplanes in the numbers given be purchased at once: 100 Lepere 2-place corps observation, 50 Loening 2-place pursuit, 100 Ordnance Engineering Corporation 1-place pursuit, 100 Thomas-Morse 1-place pursuit, 50 USD9-A day bombardment, 700 additional Hispano-Suiza 300 horsepower engines, 2,000 parachutes. All of the above types are the equal of or better than anything in Europe."

MITCHELL.²⁷

However, by the early 1920s, even with Brigadier Mitchell pushing the industry and military to create an even more potent air force, the Army had become hollow and the air service, which had more than 20,000 pilots during World War I now numbered just 880.²⁸ The air service, despite having sunk a battleship at the direction of Billy Mitchell, numbered less than 2,000 aircraft, three quarters of which were obsolete.²⁹ Likewise, the aircraft industry, which had eventually mastered the process of producing these complex machines and came close to mass production, was now withering away to pre-war capabilities. The nation, critics and supporters alike, would have to wait for the next Great War to see the American aviation industry come back into its own.

Aviation Industry (World War II): 50,000 Planes A Year!

The prelude to America's military aviation industrial success during World War II dates back to 1920 when the National Defense Act was signed and again in 1926 when the Air Corps Act, changing the Air Service to the Air Corps, was established. Perhaps most importantly, as a result of the failure of America's mobilization during WWI and a determination to be better prepared for any future conflicts, the Army Industrial College was established. Now known as the Industrial College of the Armed Forces, the school was given the primary mission of focusing on wartime procurement and mobilization procedures. Coming into its own in the 1930s, the Army Industrial College and its alumni, including GEN Dwight D. Eisenhower (1933), were now a major contributor to the mobilization plans. As opposed to post World War I plans which operated on the premise that "men would simply be equipped supplied and trained

as they entered service,” these plans would “ensure success and minimize the burdens of wartime procurement.”³⁰ The mobilization plans produced from 1933 until 1939 matured and could best be described as “administrative blueprints for wartime civilian control and direction of the nation’s resources.”³¹

With the signing of the Munich Pact in September 1938, and realizing that war was again a real possibility, President Roosevelt began to prepare. In November, “he summoned his principal military and civilian advisors to the White House and laid his views before them...the effective rearming of the nation’s ground and air forces took its start.”³² During this meeting, it was evident that the President had taken a keen interest in rearming the air forces of the United States and providing the required industrial base and that this effort should occur with “all possible speed.”³³ The President’s focus on this one element, it seems, was the result of the many reports he received concerning Great Britain and France’s alarm over the German air expansion. In fact, some at the meeting expressed belief that the President’s vision was an industrial base to produce aircraft for those countries that would “overawe Hitler or that, if war should come, could even help defeat Hitler without American armed intervention.”³⁴ Spurned by the resounding isolationist attitude at the time, it became evident that spending taxpayer dollars to support these nations with an arsenal was not possible. The President’s answer was the justification of an Army aircraft production requirement that would energize the entire industry. It would also provide the means to create the desired outcome—massive aircraft production capability that could be siphoned off and sent overseas when the time was right. It should be noted that the General Staff was not in support of this rapid growth and that for the first time in United States history, “the Commander in Chief, rather than the Army establishment was pressing for national rearming.”³⁵

Utilizing the fact that the Air Corps had only 1600 of the 4000 aircraft called for in the 1936 Baker Board recommendations, the President had a springboard for action.³⁶ However, with only 49 daylight bombers and 140 pursuit aircraft deemed “acceptable for the new battle conditions,” the situation was much worse than just numbers of aircraft on hand.³⁷ Aircraft production was horrible as well, with the Chief of the Air Corps reporting a maximum production rate of 88.2 airplanes per month.³⁸ When compared to an annual capacity of 400 aircraft a month in Great Britain, 300 aircraft a month in France, and the staggering 1200 aircraft

a month of Germany and Italy combined, the situation was grim.³⁹ The President directed a desired end strength of 20,000 aircraft for the Army Air Corps with an annual production capacity of 24,000 airplanes.⁴⁰ Understanding that the political climate would not permit such a staggering expenditure of funds, the President cut his request down to 10,000 aircraft, a number that was already circulating through Congress and was received in good regard. In the end, his stated objectives were “(1) production over a two-year period of 10,000 planes as described, of which 8,000 would come from existing commercial plants and 2,000 from new plants to be built with government funds and (2) the creation of unused plant capacity for producing 10,000 planes annually.”⁴¹ A total of seven plants were to be constructed, with two assuming production immediately and the remaining five being held idle until needed. On January 12, 1939, President Roosevelt addressed Congress and requested \$525M, of which \$250M should be spent by the Army for the purchase of no less than 3,000 aircraft. The President also requested that an additional \$50M should “be made immediately available in order to correct the present lag in aircraft production due to idle plants,” and \$10M a year be provided for training 20,000 pilots and aircrew.⁴² On April, 26, 1939, the President signed the appropriation bill providing \$300M for the construction of a 6,000 plane Army Air Corps—the United States had begun its march to have the largest air armada to ever take to the skies and the greatest aviation industry in the world.⁴³

While the production of aircraft at existing factories continued, the problem of constructing facilities became a significant issue. The impact of this dilemma could have been detrimental, but it was tempered by the influx of funding and requirements from both France and Great Britain before 1940, and Britain after 1940, which, along with our own order for new aircraft spawned significant growth in production capacity. In May 1940, with the continued spread of Nazi domination across Europe assisted greatly by the Luftwaffe, President Roosevelt again spoke to Congress and requested even greater aircraft production – 50,000 aircraft per year, including the estimated requirements of the Royal Air Force.⁴⁴ With the War Plans Division still coming to grips with how to grow the aviation industry, this problem continued to get more daunting with the passing of the Lend Lease act of March, 1941. With England involved in the fight for its existence in the Battle of Britain, and Russia and China at war with Nazi powers, President Roosevelt directed that the Army’s allocation of aircraft on the

production line now be diverted to support those countries and their fight. It was now crucial that the Army fix the aviation industry or risk being without the very aircraft it so needed to change to a wartime footing. However, this was not the Army's problem alone; the lawmakers played their role as well.

Born of an act authorizing the Reconstruction Finance Corporation (RFC) to "lend money or to buy stock in corporations organized to promoted national defense,"⁴⁵ the Defense Plant Corporation (DPC) was established. Designed to provide funding to the many contractors needing additional capacity to meet the wartime requirements, the DPC was intended to underwrite those efforts deemed too risky for private banking establishments. Two other key pieces of legislation that had a significant impact on the aviation industry during these critical buildup times were the Vinson Act, which focused predominantly on the Navy but had an overwhelming impact on Army contracts as well by limiting profit, and the act proposed by Representative May, chairman of the House Military Affairs Committee.⁴⁶ May's legislation permitted the Army to make use of negotiated and "Cost Plus Fixed Fee contracts, advance payments, and actually authorized the government to undertake the erection of facilities even when this had to be done on private sites."⁴⁷

These three sweeping changes provided the military, and more specifically the Army, the opportunity to have a chance at meeting the Presidents goals. Both Services were now provided "sweeping grants of discretionary power to escape the time-consuming restraints of peacetime competitive buying and to place orders with smaller and weaker concerns that could never have won orders competitively, thus broadening the base of defense production."⁴⁸ While being given great latitude, it wasn't until 1942 that these powers had been vetted, found deficient and a "patchwork" of legislation finished what was intended.⁴⁹

One piece of repair legislation that impacted the aviation industry the most was the Second Revenue Act of 1940. This statute removed the limitation of profit from the manufacture of aircraft. Originally limited to 7% and subsequently 6% by Congress, it was found that while manufacturers were willing to work for low profit margins, the sub-contractors, who could work for whoever they wanted, would not and often went to industries such as munitions manufacturing which had not been hamstrung by set profit margins. With the removal of the profit limitations, contractors were now able to bid on and win these critical contracts.⁵⁰ The

second feature of the 1940 act was the rapid depreciation of facilities which were deemed “necessary of defense” by the Secretaries of Army and Navy.⁵¹ With record high taxes, a significant write off was just the incentive to get the manufacturers moving. While successful, manufacturer financed facilities were not the predominant manner through which aircraft facilities were established.

In lieu of the Emergency Plant Facility (EPF) which was funded by private banks, contractors received liberal federal tax write-offs and still required contractors to deal with states concerning taxes; it was the Defense Plant Corporation (DPC) which became the predominant method of growing the aviation plant capacity. First tried in 1940 with the Packard Motor Car Company, by the end of the war a total of 935 DPC efforts had been completed with more than 740 being aircraft, aircraft sub-component, or parts production facilities.⁵² While the air arms accounting of these efforts differs, the fact cannot be disputed that the billions invested in these facilities paid off in the previously unimaginable numbers of aircraft that rolled off the production lines during the war years.

This significant funding provided an average of 4% for the land, road, and railroad spurs, 35% for facilities construction, and the remaining 61% for tools.⁵³ One thing the money could not buy was time. In fact, the average time from the decision to build a new aircraft manufacturing production line to full rate production ran from an average of 31 months for fighter aircraft to 40 months for the B-29 super fortress.⁵⁴ This is in contrast to the Army planner’s assumption of 18-20 months in 1940.⁵⁵ These assumptions were wrought with an over-exaggeration of specialty tool manufacturer capabilities, the availability of existing floor space and the ability to train, retain, and house the millions of workers required to execute the production of these complex pieces of machinery.

In 1937 the aviation industry had a workforce of approximately 24,000, which produced 3,100 aircraft.⁵⁶ By 1941 the workforce totaled 180,000 workers and the floor space available had doubled to nearly 24 million square feet.⁵⁷ In contrast, by the end of the war the aircraft manufacturing workforce, including airframe, electrical, propeller, engine, landing gear, and supercharger, totaled somewhere in the range of 2.2 million workers working on aircraft and components manufactured on well over 100 million square feet of floor space.

Because a large number of the pre-Pearl Harbor aviation workforce was drafted or volunteered for duty as a part of the largest Air Force in the history of the world, the manufacturers were left to create a new industry capable of producing even greater numbers of more and more complex aircraft. The government was involved in this as well. In fact, in the year and a half prior to Pearl Harbor, nearly 2.5 million workers in all vocations had received training in “1,200 vocational schools, 155 colleges and universities, and in 10,000 public school shops.”⁵⁸

Perhaps the greatest example of the conversion to wartime aircraft production is Ford Motor Company’s Willow Run Plant which was designated to produce the B-24 Liberator. Looking to create a wartime industry second to none, it was only a short time before the auto industry would become involved. Possibly at the behest of the head of production planning for the National Defense Advisory Commission, William Knudson, the former head of General Motors, the auto industry became involved in more than vehicle production...they were now in the aircraft building business. While many plants were converted to wartime production of airplanes, the best known, for good and bad, is the newly constructed Ford Motor Company Willow Run Plant. Fraught with problems since its April 1941 ground breaking, it was commonly referred to by the locals as the “Will It Run”⁵⁹ facility and became the subject of a Senate investigation. Fighting manpower shortages, later resolved by planned housing and training programs, and replacing improper tooling brought in from the auto industry, the facility produced over 100 B-24’s by December, 1942. However, only 52 were accepted by the Air Corps due to extensive flaws in manufacturing.⁶⁰ The auto industry quickly learned that mass producing an automobile with its thousands of parts is much easier than producing a complex aircraft with its 100,000+ parts. Following hundreds manufacturing changes and the resolution of workforce issues, including the incorporation of women into the workforce, the plant became what it was designed to be, a mass production facility producing one of the most complex pieces of machinery known to man. In a short 10 months from the production of its first B-24, the plant was producing 231 aircraft per month.⁶¹ By the end of 1944 that number had increased to 650 per month, or a little more than one per hour for the two shifts. Mass production was not without its issues though. Engineering changes or modifications to airplanes being mass produced required significant retooling, which required shutting down production and retraining the

workforce. In contrast, the Boeing B-17 plant in Washington was predominantly built by teams of tradesmen in stations. As a result, changes to those aircraft had relatively little impact on production rates. It should be noted, however, that production of any aircraft outside of the B-24 plant at Willow Run never reached the rates Ford was able to achieve.

The ability of the nation to produce the 50,000 aircraft a year as called for by President Roosevelt was, as Maj. Gen. Henry H. “Hap” Arnold, Chief of Army Air Corps, called it, enough to “stagger any mere officer.”⁶² Little did he know that the president would call for 125,000 planes the next year in his 1942 Report to the Nation. Staggering then, it still is. However, the industrial might of the nation and the fortitude of the workforce did make it happen. In the end, 53 manufacturers at 81 different production plants produced, from 1940 to 1945, more than 299,000 aircraft and over 800,000 engines.⁶³ In total, the United States Air Corps lost just over 65,000 aircraft during World War II.⁶⁴ To contrast, the German Luftwaffe produced just fewer than 95,000 aircraft and lost just over 40,000.⁶⁵ President Roosevelt was correct in his assumption; the ability of the United States to out-produce its enemy had won the war. Would we be right the next time?

Aviation Industry (The Other Wars): Enough Planes?⁶⁶

With the end of World War II and having gone through the costliest war ever, the United States believed that the world would be peaceful once again. As a result, the Air Corps, with over 63,000 active aircraft at the end of hostilities, placed a large number of aircraft in storage, provided many to allies as a form of foreign aid, and destroyed the remainder.⁶⁷ In fact, of the original 243 Combat Groups which were available at the end of 1945, only two of the 52 authorized were combat ready in July 1946.⁶⁸ Aircraft on hand at that time could not be identified, but in 1949 the number of active aircraft totaled just over 9,000.⁶⁹ Likewise, aircraft production was whittled down to only necessary production and a majority of aircraft producers began the process of retooling to pre-war manufacturing leaving just 18 in the business of military aircraft production at the beginning of the Korean conflict.

Following its conversion from the Army Air Corps to the United States Air Force in 1947 and struggling to keep itself seen as a venerable force, the Air Force was to get its first challenge with the Berlin blockade in June 1948 as the Cold War kicked off. Not ending until 321 days later, the Air Force had passed its first test with flying colors. With little more than leftover

World War II cargo aircraft, the air force delivered over 2.3 million pounds of food and supplies, ultimately breaking the stalemate.

It was not until June 25, 1950, when North Korean forces invaded South Korea that the United States Air Force and the industrial might of the nation would again be turned on to counter an enemy in the skies and on the ground. However, with little warning of the looming conflict in Korea and a skeleton of the forces available during World War II, the United States was ill-prepared for this war.

Much had changed with the industrial footing of the United States as well. Prior to World War II, President Roosevelt had seen the looming crisis and was able to posture his position with Congress, the military, industry, and the people to begin preparing the industrial might of the nation for the coming world war. Korea was a different matter, as the United States did not want another war. With the economy booming and many soldiers, sailors, marines, and airmen just having returned from years away from their families, the country's population didn't see the need to become involved with another conflict; especially in the Far East.

It appears that many, including the President, in 1950 believed that the 9,000 aircraft held in storage, the existing active duty fleet and limited new production could easily defend the United States.⁷⁰ As opposed to World War II, when President Roosevelt saw the need for a rapid growth military aircraft, President Truman did not. While he stated that "within a year, we will be turning out planes at five times the present rate of production" during his December 15, 1950 report to the nation it would have only amounted to 20% of World War II production.⁷¹

While delays are inevitable during the production of any new complex piece of machinery, it appears that many of the lessons learned during World War II aircraft production were lost in five very short years. In fact, President Truman's desire for a five-fold increase in production in one year was never achieved during the conflict. In fact, the maximum number of aircraft accepted by the USAF during this conflict occurred came in 1952 at 7403.⁷² While some of these delays were to be expected with any new production line, it was later identified that the majority of issues came from the same problems that had been identified and rectified during the previous war: floor space, component availability, and the allocation of limited skilled resources to what was believed to be the highest priority.

The Air Force tried to resolve these issues during the buildup and in 1951 issued 213 contracts for specialized manufacturing.⁷³ Numbering only 28 in 1949, these industrial facilities grew by 15 in 1951 and another 28 by 1952, finishing the war out with a total of 71.⁷⁴ Of particular note was the number of spare engines available in the United States stockpiles of war reserves. Built up during World War II, these critical components, like the aircraft which used them, had been retained in the event of crisis. Likewise, the depots, 16 in 1949, which repaired them were, while limited in their capability, available with trained personnel to meet the demand.⁷⁵ In fact, during World War II, when it was easier to order a new airplane or engine as opposed to returning it to the United States for repair, these depots performed nearly 275,000 engine jobs.⁷⁶ Likewise, during the Korean War those specialized depots that remained plus the jet engine manufacturers themselves, performed nearly 85,000 engine jobs on a fleet of aircraft less than one sixth the size of the average World War II fleet.⁷⁷ Indicative of the infusion of the jet engine, which required an overhaul at approximately 1/10th the time of a piston engine, it is clear from the Air Forces statistical data that it took approximately one to two years before the these depots could reach any appreciable volume of work. Whether this is a result of needing to train additional personnel or secure the proper tooling or floor space is unclear. The same can be said of airframe depot workload. With evacuated damaged aircraft needing extensive repair and/or modification, air depots were utilized to meet these requirements as well. While data is scarce on the Korean War as to how beneficial these depots were, the little data provided on World War II is inconclusive as to how important these facilities were to the overall status of the fleet. What is known concerning World War II depots is that when mass producing aircraft, the insertion of an engineering change to an aircraft either stopped or significantly slowed down the production line. As this was the case, many aircraft produced during World War II were manufactured as originally specified, then, only after leaving the production line were the aircraft modified to the desired configuration. This was particularly true of those aircraft produced in mass production lines like Ford's Willow Run. As was noted by Time Magazine in 1951, that "instead of freezing their designs for mass production, most manufacturers were slowing down production from time to time, retooling for improved models," it seems that Korean War manufacturers grappled with this problem as well.

In the end though, the Korean War ended in 1953 with China, not Russia, entering the war with ground troops and the United States Air Force receiving 19,435 new aircraft.⁷⁸ While Russia had provided the North Koreans with the MIG-15 jet fighter, United States designers were quick to respond. Begun in 1943 with the P-80 Shooting Star, a myriad of other jet aircraft took to the skies over Korea. Another new aircraft seen in those same skies was the newly integrated helicopter. Primarily utilized for medical evacuation, the helicopter's true potential was just beginning to be seen. At the end of the conflict, new aircraft production, surplus World War II aircraft and the industries that support them took the day. This was not without cost, however, with the United States Air Forces losing a total of 1463 aircraft to combat.⁷⁹ It should be noted that this number does not include those aircraft shot down, recovered, repaired and placed back into service. Of particular interest is the fact that in 1952 and 1953 the loss of these aircraft to ground fire while supporting the Army and Marines, one of the Air Force's primary roles, was a significant 38%.⁸⁰ The number of aircraft lost during air-to-air combat and unknown enemy action was only 14% and those not lost to enemy action and unknown causes totalled the remaining 48%, a staggering number.⁸¹

With the end of the Korean War the United States, still attempting to stem the tide of Communism with the Cold War, continued to modernize and update its fleet of aircraft from World War II propeller-driven aircraft to the high-speed, efficient and, in the end, more economical jet aircraft. This fact is exemplified by average number of USAF aircraft on hand, either active or in storage, which had an age greater than eight years old during the Korean War years.⁸² Averaging just over 17,000 aircraft, this represented 85% of the fleet. By contrast, the number of aircraft that had aged at least 8 years in 1959 represented just 11% of the fleet.⁸³ The Air Force was getting healthy again.

Maintaining this ratio of old to new aircraft throughout the 1960s, the United States Air Force had become reliant on the infusion of new aircraft to refresh the fleet. While the justification was warranted with the maturation of the jet engine and the complex machinery it propelled, the majority of these new aircraft were in response to an arms race with the Soviet Block nations during the Cold War. Entering Vietnam in 1965 in appreciable numbers, the USAF started taking losses that would climb from 35 in the first year until the end of the conflict with a total of 1622 aircraft lost.⁸⁴ Replacing these aircraft were an average of 11 aircraft

manufacturers producing a total of 9831 aircraft during the conflict.⁸⁵ Again, the United States had outproduced its enemy and, while not winning the war, had won the industrial conflict.

Coming of age during the Korean War, the helicopter came to the forefront of military utilization during the Vietnam War. Seen by the Army as a manner in which to quickly move soldiers around the battlefield, the Army adopted the helicopter as the new tool for executing warfare. Originally powered by piston engines, the helicopters in use during Vietnam were powered by the venerable turbine engine. Light and extremely powerful, the turbines allowed the helicopter to mature into an aircraft that was seen as invaluable. First introduced in Vietnam in 1961 following the delivery of 183 HU-1A's transport helicopters, 15 HU-1 specially configured gunships were deployed for evaluation in countering guerilla operations.⁸⁶ Yielding favorable results, and with the Cold War brewing in Europe and the situation in Southeast Asia worsening, more and more uses for the new machine were envisioned and the aircraft became integrated into Army doctrine. Following the introduction of troop-carrying helicopters into Vietnam in 1962, it became clear that these new machines would play an even more significant role in Army doctrine. However, as discovered in 1963 at the Ap Bac, this was not without risk. A combined force of 10 H-21 Transport helicopters and 5 HU-1A gunships conducted an air movement with 14 either destroyed or damaged.⁸⁷

Accepting the risk, seeing the potential, and being completely dissatisfied with the ongoing unwillingness of the Air Force to provide the required close air support, caused more than likely by their high loss rates seen in Korea, the Army set off on building its own aviation fleet. Unlike the Air Force who gained its rapid growth during World War II and maintained its size through multiple aircraft manufacturers, the Army would do so with large numbers of aircraft from a relatively small number of manufacturers, approximately eight. While manufacturers like Sikorsky and Boeing were involved, the major producer of the the Army's massive helicopter fleet was Bell Helicopter. Born of World War II, the helicopter company would find its place in history as the manufacturer of the UH-1 family of aircraft. Producing just over 10,000 aircraft from 1957 to 1975, the Army received 9,225, including nine prototypes.⁸⁸ As the conflict progressed from an assistance role to full out war, the helicopter continued to make strides and was seen as more and more crucial to the Army. However, as use increased, so did the potential for losses. No where is this more evidenced than in Lam Son 719, the US

supported South Vietnamese invasion of Laos. In less than 60 days the US Army lost 106 aircraft which were destroyed and had 512 more damaged.⁸⁹ In the end, of the 7,013 Hueys which were utilized in Vietnam, more than 3000 were destroyed. In fact, of the 11,927 helicopters which are known to have flown in the Vietnam War, nearly half, 5,086, were destroyed.⁹⁰

Following Vietnam, the United States Army, still realizing the value of the helicopter to national defense and Army warfighting doctrine, invested significant time and resources into creating a new generation of aircraft which would be required on future battlefields. Paramount to this was an attempt to stem the high injury/death toll from accidents and loss rates of aircraft by designing safer and more survivable aircraft. This new generation of aircraft, following the Air Force and Navy's lead, were also to be a technical leap forward in almost every measure with higher kill ratios for the gunships and greater measured capabilities for the utility aircraft. The Army was now, in tight budget times, in the business of selling itself and its requirements to congress. Learning from the Air Force the Army was now providing the funding information necessary to get the aircraft it required.

In contrast to the Air Force whose only focus was aircraft and space vehicles, the Army was a ground combat unit with a multitude of other tanks, vehicles and weapons to purchase. The Army's air wing was decentralized and, some believed, improperly organized to reap the benefits. Spread out among the Transportation Corps, Field Artillery, Armor, Medical and other branches, it was not until the late 70s and early 80s that the significance of Army aviation forces having its own branch was realized. Spurred on by the the officers from the many branches who performed duties as pilots and recognized the value of Army Aviation, the Aviation Branch was designated as a separate branch on April 12, 1983.

The aircraft envisioned as a result of the Vietnam War and war plans designed to defeat the USSR Armies invading through the Fulda Gap in Germany, the AH-64 Apache Attack Helicopter and the UH-60 Blackhawk Utility Helicopter, were now a reality. Designed by engineers who numbered nearly one hundred and forty thousand at the beginning of the Vietnam War and built by an aviation workforce that grew significantly as well to meet the increasing needs, these aircraft were just what the Army needed. Following the post Vietnam hollow Army years came the 1980s, a new President, and a new plan – outproduce the Russians and force them

into bankrupting their country by trying to keep up with US manufacturing. With the Reagan build-up of every service and their machinery of war came a revitalization of Army Aviation aircraft. Mostly Vietnam vintage, these helicopters needed upgrades and extensive sustainment activities to support them. As well, newer helicopters that included laser guided weapons, night and thermal sights, required an accompanying ground swell of engineers and tradesmen to build them. While increasing, the R&D and engineering workforce had only grown to a little more than half of those numbers seen during the 1960s. The aircraft and parts manufacturing sector had swelled as well. While nowhere near the estimated 2.1 million workers employed during World War II, the workforce did reach over 550,000 in 1983, peaking at 712,000 just seven years later.⁹¹

Following Desert Shield and Desert Storm, where the new aircraft proved their worth and vintage aircraft showed their limitations and age, and the fall of the Soviet Union, Army Aviation, along with the rest of the Army reassessed its future as Congress and the people of the United States looked for their peace dividend. Having been provided funding to replace 3,200 Vietnam era helicopters during the 80s, Aviation Branch now found itself in the unfortunate place of having funding removed after receiving only 2620 of its planned purchase.⁹² Approved by the Army Chief of Staff in 1993, the Aviation Restructuring Initiative (ARI) provided a road map for Army Aviation which would reduce costs, right size the fleet, which possessed more of the wrong type of aircraft than were required and ensure desired capabilities were present well into the 21st Century. Selectively choosing to reduce in certain areas while growing in others, they would, after 2004, begin to modernize the fleet and reduce the overall costs. With the predominance of growth required in the Scout/Attack role, the Army invested heavily in modernizing the AH-64 and developing and producing the RAH-66 Commanche. Designed primarily to replace the aging and predominantly outdated OH-58 scout/reconnaissance helicopter fleet, the Army wanted to purchase nearly 1,300 of the new aircraft. This approach, while reducing the number of Scout/Light Attack aircraft by 600 and heavy attack (AH-64) aircraft from 930 to 560, would allow the recon and attack fleet to push well into the 21st century before requiring another upgrade.⁹³ Likewise, the utility and cargo fleets would right size as well. Building on the strengths of the relatively new UH-60 and the venerable CH-47, while

divesting of the antiquated UH-1, the cargo/utility fleet would decrease in size by the year 2000 by 1240 aircraft.⁹⁴ Another reduction of 230 would come by 2030.⁹⁵

By 1994, however, Army Aviation was no longer buying any new aircraft and in its 1996 budget proposal there was no funding projected for new aircraft from 1996 to 2004. An aggressive plan, the critics of ARI were everpresent and the congressional budget office even offered up, in late 1995, its own *Analysis of US Army Helicopter Programs*. While believing that ARI would “significantly improve the capabilities of its attack and scout” fleet, it also saw that the these “improvements would come at a relatively high cost...and would not address the problems of increasingly aging utility and cargo fleets.” ARI was eventually put into action as a plan to remove all legacy aircraft from the inventory while simultaneously modernizing National Guard Aviation Units, this resulted in many active duty unit’s aircraft authorizations being reduced as there was no new production authorized.

The plans weaknesses became all too evident when lessons learned from Operations Enduring and Iraqi Freedom showed that the aviation force structure, now nearly 1,000 below those called for in ARI, was inadequate to meet the ground commanders requirements for large scale movements and close combat operations.⁹⁶ With this in mind, Army leadership made the difficult decision to kill the Comanche program in 2004 and request permission to divert the funding to other critical aviation programs and efforts. Receiving approval, the Army was quick to focus its efforts on resetting aircraft involved in Operation Enduring and Iraqi Freedom, modernizing the fleet with upgrades and the insertion of new aircraft, like the ARH-70 and UH-72A, to replace costly, older aircraft in the inventory.

In its 1995 study to analyze the effects of the decline in purchases during the previous 10 years on the helicopter industrial base, DoD found that the four major manufacturers would remain strong and viable into the future. Believing that excess capacity would be filled by outside orders and expected growth, they have, in fact, shrunk and one company merged with another, leaving Bell, Boeing, and Sikorsky left to sustain the production requirements of the Army. Since 1990, the US aircraft, engine and parts workforce has seen a decrease of more than 44% or just fewer than 300,000.⁹⁷ While the big three helicopter manufacturers have not realized as nearly a significant decrease during the same time period, the situation is still grim.

The US industrial base, which so masterfully provided the US military with the tools required to win every conflict since WWI, is no longer prepared to meet emergency requirements of US Army Aviation. Already short aircraft due to previous decisions, the Army now has to wait, from contract award, 18 months for delivery of a UH-60, 28 months for a AH-64 and 34 months for delivery of a CH-47.⁹⁸ PM Apache was right, the answer was not an easy one.

Aviation Industry (Current Situation): Where do we get the replacement aircraft from?

History demonstrates the potential for loss of aircraft performing close air support is high. Korea showed that 38% of all operational aircraft losses were a result of aircraft performing the close air support mission (aircraft brought down by ground fire).⁹⁹ Vietnam demonstrated this once again with loss rates for Army helicopters due to hostile action exceeding 51%.¹⁰⁰ While the US Army has not been involved in a conflict of that magnitude or with that level of threat, it does not mean that helicopter operations in OEF and OIF don't tell a similar tale. With average yearly losses equaling just 23% of losses sustained by the Air Force each year in Korea, the impact to the army is still significant. As of October 2007, US Army Aviation had lost a total of 159 helicopters (CH-47, UH-60, OH-58D, and AH-64), 108 of which were lost as a direct result of supporting combat operations.¹⁰¹ Because Army Aviation is always in support of the ground troops, it is, while the air defense threat in OEF/OIF permits operations at higher altitudes, doctrinally operating in closer proximity than any other air asset (Sister service rotary wing elements excluded). As a result, a pilot's risk of crashing into unseen/unmarked cables or antennas, not having enough time to react when an in-flight emergency occurs or susceptibility to enemy small arms and anti-aircraft fire is considerably higher than their counterparts in the Air Force or Navy fixed-wing communities. In fact, the statistics from both Iraq and Afghanistan prove this out. While 68% of Army aircraft lost since 2001 were lost in support of OEF and OIF, it does not properly describe those lost due to the combat operations.¹⁰² Army Aviation losses due to close support combat operations (41%), after ruling out situations such as incidents which could occur on the ground (Auxiliary Power Unit Fire, etc.), crashes on takeoff or landing, or crashes during training events such as gunnery, parallel losses of those sustained during Vietnam and Korea.¹⁰³

The Army began this conflict already in a deficit and currently has just 95% of its required end strength (3414).¹⁰⁴ Figuring in funding received, the Army will accept in the next

three years just 90 aircraft, bringing its total on hand, not counting future losses, to 3,330 or 98% of required.¹⁰⁵ In fact, the US Air Force and US Navy also have 12% and 11%, respectively, of their total aircraft inventory for FY07 designated as Backup Aircraft Inventory.¹⁰⁶ Designed to provide immediate replacement aircraft for operational losses and float aircraft for maintenance and modification, our sister service air wings have their secretariat's support in preparing to sustain aviation operations. Also, the Air Force and Navy have, as part of their overall strategy, and will continue to maintain into the future a strategic reserve of mothballed aircraft at one of many Aerospace Maintenance And Regeneration Center (AMARC) facilities throughout the United States. Unfortunately, the Army has no strategic reserve of helicopters. What was held in reserve were the aircraft of the United States National Guard. However, as the operation tempo required to sustain operations in Iraq, Afghanistan, and elsewhere around the world has exceeded that of the active component, National Guard Aviation has had to assist with units, personnel and equipment and is now folded into the Army Forces Generation (ARFORGEN) process. As a result its equipment can no longer be utilized as a strategic reserve of replacement aircraft until new ones come off the production line or out of reset. Reset, the process of repairing and modifying aircraft to the most current configuration, is accomplished primarily at the Corpus Christi Army Depot. While the Army has over 160 bays available for this extensive overhaul, the units that provide them upon return from overseas are left with no aircraft to train on as the Army has no backup aircraft inventory.¹⁰⁷

When the Air Force or Navy justifies a new aircraft purchase to congress, it can utilize kill ratios, number of potential threat aircraft in the future, potential loss rates, maintenance cost efficiencies gained and expected useful life, descriptors that are relatively easy to understand. Army Aviation, on the other hand, cannot even begin to adequately describe the enemy it will face. How many personnel wielding AK-47s and rocket propelled grenades (RPGs) will an OH-58D Kiowa Warrior face on any given day? Which round from one of the millions of small arms weapons in the world will bring it down? Which unmarked power line will the aircraft hit while trying to provide air cover to a convoy?

While it may be relatively easy to describe the number of AH-64's the Army needs to fend off the massive number of tanks coming through the Fulda Gap or Chorwan Valley because we know the enemy's order of battle, vehicular make up, and the number of Hellfires each

aircraft carries and the probability of a kill, no longer lives in the times justifying aircraft end strength or production needs in that manner. The manner in which we justified Army Aircraft purchases in the past is outdated. The Army must think in terms of historic loss rates when fighting an enemy that is not driving tanks, utilizes stolen, captured or black market equipment or modified ground weapons for air defense. All the while we must still be prepared to do battle with another peer military force.

If the scenario described at the beginning of this paper were true, units that were preparing to go into combat would have their aircraft transferred into theater with no replacement arriving for years. As a nation we must be better prepared to wage and sustain continuous combat operations in an unsure world, and in order for Army Aviation to retain its combat capabilities we must do the following:

- Obtain immediate funding to replace existing 82 aircraft shortfall (Note: this number accounts for 90 replacement aircraft already funded).
- Obtain Congressional funding and authorization for increasing helicopter end strength to meet reset and aircraft loss requirements as follows:
 - **Attack** aircraft to **123%** of required. Includes 115% for optimal reset Equipment Force Pool (EFP) sizing.¹⁰⁸
 - **Scout** aircraft to **115%** of required. Includes 105% for optimal reset EFP sizing and assumes ARH deliveries on schedule to replace aging OH-58D fleet.¹⁰⁹ If OH-58D's are retained, the required % will be similar to Attack aircraft requirements due to the age/health of the OH-58D fleet.
 - **Utility** Aircraft end strength to **115%** of required. Includes 111% for optimal EFP sizing.¹¹⁰
 - **Cargo** Aircraft end strength to **121%** of required. Includes 117% for optimal EFP sizing.¹¹¹

*Note: Replacement aircraft percentages are based on loss rates incurred during OEF and OIF and assumes ten Combat Aviation Brigades deployed during a year. It is assumed that given immediate notification of ramp up, existing aircraft production would

optimize within one year. If conflict is expected to be similar to Korean War, then losses will exceed production capacity within approximately 5 months.

- Place additional attack aircraft in reset pool and Army Reserve Aviation Units for warm storage. Maintenance test flights only. Place reserve utility and cargo aircraft in reset pool and remainder under US Northern Command, performing missions in support of homeland defense. When required, the aircraft would be transferred back to US Army Aviation units.
- Establish US Army Helicopter Industrial Board to continually analyze the US industry with a charter to:
 - Make recommendations for militarization of commercial fleet production (aircraft and assembly lines).
 - Analyze supplier base for critical weaknesses and US dependency on foreign manufacturers and provide recommendations to limit deficiencies.
 - Establish pre-planned engineering change proposals which could be utilized immediately in the event of a wartime industrial conversion decision.
 - Make recommendations to Secretary of the Army concerning percentage of aircraft which should be procured and placed in strategic reserve.
 - Develop triggers which will activate war-time production of military helicopters
 - Monitor the health of the Industry.
 - Work with other US Government Departments to ensure funding, grants, and scholarships are provided to promote aviation trades.
- Secure empty floor space (Willow Run, etc.) in economically hindered areas such as Detroit, which has an unemployed skilled workforce.
 - Coordinate transfer of vetted out-of-production aircraft manufacturing tooling and establishment of cold production facilities of legacy aircraft production to meet critical rapid war-time needs.
 - Invest in automation of aircraft manufacturing processes to speed production line capability. Utilize this production capacity as gap fillers until regular production lines for premier aircraft can be optimized for maximum wartime production and the workforce can be trained.

- Authorize, as President Roosevelt called them, “educational orders” for all aircraft to sustain viable production lines and the work force to produce them.

Conclusion

Brigadier General Billy Mitchell, seeing the value of the airplane in prosecuting and winning wars, sacrificed his career in an effort to ensure that America gained and maintained the most technologically advanced and lethal airpower in the world. Courts martialled, found guilty and suspended from rank, Colonel Mitchell spent the remainder of his life continuing to espouse the ideals in which he so believed. Dying in 1936, he never saw his life’s dream realized. As the Army stares into the dawn of the 21st century it can look back to World War II and see the rise of the greatest airpower supported by a previously unimaginable aircraft manufacturing industrial complex....producing nearly 300,000 aircraft in five short years. In fact, the Army can see the birth of what is today-the most technically advanced Army air component in the world.

However, like the 1920s and 30s, when Colonel Mitchell believed the nation was at risk, we still are in peril. While it is not associated with technology and survivability of the pilots and passengers as it was during his time, it is associated with the capacity of this country to engage in and win wars through sustainment of its forces. The US military has allowed the aviation industrial base, which is so vital to this country’s interests, to wither away. The US Army has no strategic reserve and must wait for as many as 34 months for an aircraft to be delivered, even while we are waging a war in two geographic areas.¹¹² The industries that support these aircraft have seen a consistent decline in trained personnel for more than 25 years, yet, according to the Aerospace Industries Association, they imported nearly \$2.7B in parts and engines to support the military, a risk in and of itself. The Army has no reserve pool of aircraft to provide to pilots while the aircraft they were flying are in depot being reset. If the Army sustains losses similar to those in Korea or Vietnam, with significant losses massed in a short period of time, there are no aircraft to quickly replace those lost. If that occurs, the Army’s primary warfighter, the infantryman, will be without the close air support and transportation he needs to engage and win the Global War on Terror or any other conflict this country enters into. Without that critical air support, soldiers will fight and die unnecessarily or the enemy will slip through our fingers. If Brigadier General Mitchell were here today, he would again be courts martialled for making the

same charges against the Army. The only difference would be the soldier would be substituted for the pilots of the early 1900's.

In order to resolve the existing production problems and enhance the force generation capabilities of Army Aviation, the Army must fight for and secure funding and authorization to build and maintain an equipment force pool that is predicated on reset rates and potential losses that account for the peacetime production lag when converting from peace time production to a war time footing. Additionally, an industrial board should be established to continually analyze the industry and assess its health, make recommendations to the secretary as to wartime conversion triggers, militarizing the commercial fleet, and equipment force pool sizing. While continuing to analyze the supplier base for critical weaknesses and US dependency on foreign manufacturers, this board should also be chartered to work with other government agencies to ensure the civilian workforce requirements are met well into the future. Realizing that even with the best developed plan, it will take time to convert to full wartime production, consideration should be given to creating cold production facilities. This capability, in time of crisis, could be instantly turned on to rapidly manufacture proven legacy aircraft as a means to fill the gap provided by a lagging ramp-up of existing production facilities manufacturing state of the art aircraft. Finally, the Army should ensure that educational orders are processed for aircraft components and sub-components to ensure that workforce at all levels of manufacturing are prepared to meet surge or wartime requirements.

APPENDIX 1 – Army Air Corps/Air Force Statistical Compilation: WW II, Korea and Vietnam (Page 1 of 2)

Data included in this table derived from *United States Air Force Statistical Digest*, World War II, 1949-53, 1959-1975

	1939	1940	1941	1942	1943	1944	1945	1949	1950	1951	1952	1953	1959	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Total A/C								18927	18294			23548	19416										
							20540.4	23000	20968	19921	19800	19013											
Active A/C	2546	3961	12297	33304	64232	72726	63715	9255	8585	9136		17108	17352	14095	13928	14459	14917	12016	12659	11832	10971	12158	
A/C out of Commission								4300	3107	3265													
# A/C > 8 yrs old							17173.4	18563	16990	17805	17849	14660	2297	1453	1501	1096	877	572	530	363	600		
Authorized for Prod								2324	1252	8769		5569		1182	1379	1187	1456	1269	739	740	626	721	
A/C In Storage								9032	6887	4204	2234	2024											
A/C Accepted		6028	19445	47675	85433	95272	45377	1306	2565	3735	7403	5732	2185	1356	1122	1412	1206	1102	1203	1026	787	617	1152
A/C Total Lost			445	5415	15032	28300	15972		4231	4039	5773	5990	5130	1098	2155	1816	3032	2546	2166	2059	2122		
Total FEAF A/C									925	1064	1212	1243	1111	1463									
Operational Losses - CBTt									118	305	244	89											
Air to Air									9	56	60	14											
Ground Fire									103	229	154	64											
Cause Unknown									6	20	30	11											
Not Enemy Action									104	186	139	70											
Unknown									47	102	31	28											
Operational Losses Other Total									151	288	170	98											
Non Operational Loss - Flying											73	235		253	260	261	254	264	211	134	125	119	
Non Operational Loss - Other											7	46											
A/C Not Repairable									1117	1615	1468	1346	572	383	576	643	699	518	499	327	358		
A/C Repairable									3114	2424	4305	4644	3802	1932	930	1173	2329	2123	1667	1729	1764		
A/C Lost to Combat									269	593	414	187		38	153	178	447	303	259	112	132		202.8

APPENDIX 1 – Army Air Corps/Air Force Statistical Compilation: WW II, Korea and Vietnam (Page 2 of 2)

Data included in this table derived from *United States Air Force Statistical Digest*, World War II, 1949-53, 1959-1975

[illegible]

BIBLIOGRAPHY

- 108th Congress. *Testimony of M.E. Rhett Flater, Executive Director, American Helicopter Society International*, 2004. Washington, DC: House Armed Services Committee, 2004.
- “Aircraft Production Gains, Officials Say.” *The New York Times*, 10 Apr. 1918, <http://www.nytimes.com> (accessed Dec. 12, 2007).
- “Army Aviation S&T Roadmap.” 1994. http://www.fas.org/man/dod-101/sys/ac/docs/aviation_st_roadmap_army.htm (accessed Jan. 28, 2008).
- Assistant Secretary of War. *America’s Munitions, 1917-1918*, 1919. Washington, DC: Government Printing Office, 1919.
- Brush, Peter. “*THE HELICOPTER ROAD TO VIETNAM*.” 1994. http://www.library.vanderbilt.edu/central/brush/Helicopters-Vietnam.htm#_edn12 (accessed Dec. 12, 2007).
- Congressional Budget Office. *An Analysis of US Army Helicopter Programs*, 1995. Washington, DC: Congressional Budget Office, 1995.
- Conn, Stetson. “*US Army Center for Military History*.” 10 Mar. 1959. <http://www.history.army.mil/documents/wwii/ww2mob.htm> (accessed Dec. 19, 2007).
- Department of Defense. *Providing the Means of War*, 2001. Washington, DC: Defense Dept., Army, Center of Military History and Industrial College of the Armed Forces, 2005.
- Department of the Army. *Aviation Attrition Replacement Deliveries*, 2007. Washington, DC: U.S Army G-4, 2007.
- Department of the Army G-8. *Helicopter Analysis*, 2007. Washington, DC: Department of the Army G-8, 2007.
- Department of the Army G-8. *ARFORGEN Equipment-Set_Reset and Modernization: _Potential Aviation Force Pool Needs*, 2007. Washington, DC: Department of the Army G-8, 2007.
- Department of the Army. *United States Army In World War II, Special Studies, BUYING AIRCRAFT: MATERIEL PROCUREMENT FOR THE ARMY AIR FORCES*, 1962. Washington, DC: US Government Printing Office, 1964.
- Employment in the Aircraft, Engines, and Parts Industry, Calendar Years 1983-1997, Aerospace Industries Association, http://www.aia-aerospace.org/stats/facts_figures/ff_98_99/ff98p139.pdf (accessed November, 2007)
- “*German Aircraft Losses 6 Mos Period*.” n.d. <http://www.taphilo.com/history/WWII/Luftwaffe/stats/German-Aircraft-losses-WWII.jpg> (accessed Jan. 10, 2008).
- “*Industrial College of the Armed Forces History*.” n.d. <http://www.ndu.edu/ICAF/history/index/htm> (accessed Dec. 19, 2007).
- “*Institute for National Strategic Studies, Mobilizing for War: 1939 to 1941*.” n.d. <http://www.ndu.edu/inss/McNair/mcnair50/m50c5.html> (accessed Dec. 17, 2007).
- Learning by doing in markets, firms and countires*. Edited by Naomi R. Lamoreaux, Daniel M. Raff, and Peter Temin. National Bureau of Economic Research, 1999.
- Maurer, “*Air Force Combat Units of World War II*.” 1986. <http://libraryautomation.com/nymas/usaaf2.html> (accessed Jan. 7, 2008).

Montgomery, Dave. "US aerospace industry facing labor storage." *Star-Telegram*, 20 Jan. 2008, Business Section,

Nolan, Jenny. "Detroit News." 28 Jan. 1997.

<http://info.detrnews.com/redesign/history/story/historytemplate.cfm?id=73&category=locations> (accessed Dec. 17, 2007).

Office of Facts and Figures. *Report to the Nation, The American Preparation for War*, 1942. Washington, DC: US Government Printing Office, 1942.

Roosevelt, Franklin D. "Message of President Roosevelt to the Congress, January 12, 1939." 12 Jan. 1939.

<http://mtholyoke.edu/acad/intrel/World War2/fdr2.htm> (accessed Dec. 12, 2007).

Roush, Gary. "Helicopter Losses During the Vietnam War." *Vietnam Helicopter Pilots Association*. Vietnam Helicopter Pilots Association. n.d. <http://www.vhpa.org> (accessed Nov. 10, 2007).

Rumerman, Judy. "The American Aerospace Industry During World War II." n.d.

http://www.centennialofflight.gov/essay/Aerospace/WWII_Industry/Aero7.htm (accessed Dec. 17, 2007).

Skinner, Mark S. "HyperWar: US Army in WWII: Chief of Staff: Prewar Plans and Preparations [Chapter 5]." n.d.

<http://ibiblio.org/hyperwar/USA/USA-WD-Plans/USA-WD-Plans> (accessed Nov. 20, 2007).

"TIME." 23 Apr. 1951. <http://www.time.com/printout/0,8816,821572,00.html> (accessed Nov. 9, 2007).

Total Employment, 1990 to date, Aerospace Industries Association, http://www.aia-aerospace.org/stats/aero_stats/stat12.pdf (accessed November, 2007)

"UH-1 Iroquois." n.d. <http://www.answers.com/topic/uh-1-iroquois> (accessed Dec. 17, 2007).

"US Army Center for Military History." n.d. <http://www.history.army.mil/documents/mobpam.htm> (accessed Dec. 17, 2007).

US Department of Commerce. *Aircraft Manufacturing, 1997 Economic Census*, 1999. Washington, DC: US Census Bureau, 1999.

US Department of Commerce. *Aircraft Manufacturing, 2002 Economic Census*, 2004. Washington, DC: US Census Bureau, 2004.

United States Air Force. *United States Air Force Statistical Digest*, World War II. Washington, DC: Directorate of Statistical Services, Deputy Chief of Staff Comptroller, Headquarters, United States Air Force, 1945.

United States Air Force. *United States Air Force Statistical Digest*, 1949-50. Washington, DC: Directorate of Statistical Services, Deputy Chief of Staff Comptroller, Headquarters, United States Air Force, 1951.

United States Air Force. *United States Air Force Statistical Digest*, 1951. Washington, DC: Directorate of Statistical Services, Deputy Chief of Staff Comptroller, Headquarters, United States Air Force, 1952.

United States Air Force. *United States Air Force Statistical Digest*, 1952. Washington, DC: Directorate of Statistical Services, Deputy Chief of Staff Comptroller, Headquarters, United States Air Force, 1952.

United States Air Force. *United States Air Force Statistical Digest*, 1953. Washington, DC: Directorate of Statistical Services, Deputy Chief of Staff Comptroller, Headquarters, United States Air Force, 1953.

United States Air Force. *United States Air Force Statistical Digest*, 1959. Washington, DC: Directorate of Statistical

Services, Deputy Chief of Staff Comptroller, Headquarters, United States Air Force, 1959.

United States Air Force. *United States Air Force Statistical Digest*, 1960. Washington, DC: Directorate of Statistical Services, Deputy Chief of Staff Comptroller, Headquarters, United States Air Force, 1960.

United States Air Force. *United States Air Force Statistical Digest*, 1961. Washington, DC: Directorate of Statistical Services, Deputy Chief of Staff Comptroller, Headquarters, United States Air Force, 1961.

United States Air Force. *United States Air Force Statistical Digest*, 1962. Washington, DC: Directorate of Statistical Services, Deputy Chief of Staff Comptroller, Headquarters, United States Air Force, 1962.

United States Air Force. *United States Air Force Statistical Digest*, 1963. Washington, DC: Directorate of Statistical Services, Deputy Chief of Staff Comptroller, Headquarters, United States Air Force, 1963.

United States Air Force. *United States Air Force Statistical Digest*, 1964. Washington, DC: Directorate of Statistical Services, Deputy Chief of Staff Comptroller, Headquarters, United States Air Force, 1964.

United States Air Force. *United States Air Force Statistical Digest*, 1965. Washington, DC: Directorate of Statistical Services, Deputy Chief of Staff Comptroller, Headquarters, United States Air Force, 1965.

United States Air Force. *United States Air Force Statistical Digest*, 1966. Washington, DC: Directorate of Statistical Services, Deputy Chief of Staff Comptroller, Headquarters, United States Air Force, 1966.

United States Air Force. *United States Air Force Statistical Digest*, 1967. Washington, DC: Directorate of Statistical Services, Deputy Chief of Staff Comptroller, Headquarters, United States Air Force, 1967.

United States Air Force. *United States Air Force Statistical Digest*, 1968. Washington, DC: Directorate of Statistical Services, Deputy Chief of Staff Comptroller, Headquarters, United States Air Force, 1968.

United States Air Force. *United States Air Force Statistical Digest*, 1969. Washington, DC: Directorate of Statistical Services, Deputy Chief of Staff Comptroller, Headquarters, United States Air Force, 1969.

United States Air Force. *United States Air Force Statistical Digest*, 1970. Washington, DC: Directorate of Statistical Services, Deputy Chief of Staff Comptroller, Headquarters, United States Air Force, 1970.

United States Air Force. *United States Air Force Statistical Digest*, 1971. Washington, DC: Directorate of Statistical Services, Deputy Chief of Staff Comptroller, Headquarters, United States Air Force, 1971.

United States Air Force. *United States Air Force Statistical Digest*, 1972. Washington, DC: Directorate of Statistical Services, Deputy Chief of Staff Comptroller, Headquarters, United States Air Force, 1972.

United States Air Force. *United States Air Force Statistical Digest*, 1973. Washington, DC: Directorate of Statistical Services, Deputy Chief of Staff Comptroller, Headquarters, United States Air Force, 1973.

United States Army Air Forces, <http://en.wikipedia.org/wiki/USAAF> (accessed January, 2008)

Waller, Douglas. *A Question of Loyalty: Gen. Billy Mitchell and the court-martial that gripped the nation*. 1st ed. Harper Collins, 2004.

Wolk, Herman S. "When Arnold Bucked FDR." Nov. 2001. <http://www.afa.org/magazine/Nov2001/1101arnold.asp> (accessed Dec. 17, 2007).

ENDNOTES:

¹ Assistant Secretary of War. *America's Munitions, 1917-1918*, 1919. Washington, DC: Government Printing Office, 1919, pp. 239.

² Ibid, pp. 236.

³ Ibid, pp. 239.

⁴ Ibid, pp. 236.

⁵ Ibid, pp. 239.

⁶ Ibid, pp. 240.

⁷ Ibid, pp. 239.

⁸ Ibid, pp. 241.

⁹ Ibid,, pp. 243.

¹⁰ Ibid, pp. 243.

¹¹ Ibid, pp. 244.

¹² Ibid, pp. 244.

¹³ Ibid, pp. 247.

¹⁴ Ibid, pp. 247.

¹⁵ Ibid, pp. 247.

¹⁶ Ibid, pp. 249.

¹⁷ Ibid, pp. 267.

¹⁸ Ibid, pp. 269.

¹⁹ Ibid, pp. 273.

²⁰ Ibid, pp. 278-281.

²¹ Ibid, pp. 276.

²² Ibid, pp. 276.

²³ Ibid, pp. 251.

²⁴ Ibid, pp. 249.

²⁵ “Aircraft Production Gains, Officials Say.” *The New York Times*, 10 Apr. 1918, <http://www.nytimes.com> (accessed Dec. 12, 2007).

²⁶ Assistant Secretary of War. *America’s Munitions, 1917-1918*, 1919. Washington, DC: Government Printing Office, 1919, pp. 257.

²⁷ Ibid

²⁸ Waller, Douglas. *A Question of Loyalty: Gen. Billy Mitchell and the court-martial that gripped the nation*. 1st ed. Harper Collins, 2004, pp 141.

²⁹ Ibid, pp 141.

³⁰ “US Army Center for Military History.” n.d. <http://www.history.army.mil/documents/mobpam.htm> (accessed Dec. 17, 2007).

³¹ “US Army Center for Military History.” n.d. <http://www.history.army.mil/documents/mobpam.htm> (accessed Dec. 17, 2007).

³² Skinner, Mark S. “HyperWar: US Army in WWII: Chief of Staff: Prewar Plans and Preparations [Chapter 5].” n.d. <http://ibiblio.org/hyperwar/USA/USA-WD-Plans/USA-WD-Plans> (accessed Nov. 20, 2007). pp. 126.

³³ Ibid, pp. 132.

³⁴ Ibid, pp. 133.

³⁵ Ibid, pp. 130.

³⁶ Ibid, pp. 127.

³⁷ Ibid, pp. 127.

³⁸ Ibid, pp.127.

³⁹ Ibid, pp.137.

⁴⁰ Ibid, pp.137.

⁴¹ Ibid, pp.137.

⁴² Roosevelt, Franklin D. “Message of President Roosevelt to the Congress, January 12, 1939.” 12 Jan. 1939. <http://mtholyoke.edu/acad/intrel/World War2/fdr2.htm> (accessed Dec. 12, 2007).

⁴³ Department of the Army. United States Army In World War II, Special Studies, BUYING AIRCRAFT: MATERIEL PROCUREMENT FOR THE ARMY AIR FORCES, 1962. Washington, DC: US Government Printing Office, 1964, pp. 209.

⁴⁴ Ibid, pp. 209.

⁴⁵ Ibid, pp. 284.

⁴⁶ Ibid, pp. 284.

⁴⁷ Ibid, pp. 285.

⁴⁸ Ibid, pp. 285.

⁴⁹ Ibid, pp. 287.

⁵⁰ Ibid, pp. 284-289.

⁵¹ Ibid, pp. 289.

⁵² Ibid, pp. 301.

⁵³ Ibid, pp. 327-328.

⁵⁴ Ibid, pp. 325.

⁵⁵ Ibid, pp. 325.

⁵⁶ Ibid, pp.27.

⁵⁷ Ibid, pp. 310.

⁵⁸ Office of Facts and Figures. *Report to the Nation, The American Preparation for War*, 1942. Washington, DC: US Government Printing Office, 1942, pp.39.

⁵⁹ Nolan, Jenny. “*Detroit News*.” 28 Jan. 1997.
<http://info.detrnews.com/redesign/history/story/historytemplate.cfm?id=73&category=locations> (accessed Dec. 17, 2007).

⁶⁰ Ibid.

⁶¹ Ibid.

⁶² Wolk, Herman S. “*When Arnold Bucked FDR*.” Nov. 2001.
<http://www.afa.org/magazine/Nov2001/1101arnold.asp> (accessed Dec. 17, 2007).

⁶³ Department of the Army. United States Army In World War II, Special Studies, BUYING AIRCRAFT: MATERIEL PROCUREMENT FOR THE ARMY AIR FORCES, 1962. Washington, DC: US Government Printing Office, 1964, pp. 548-549.

⁶⁴ Appendix 1.

⁶⁵ “*German Aircraft Losses 6 Mos Period.*” n.d. <http://www.taphilo.com/history/WWII/Luftwaffe/stats/German-Aircraft-losses-WWII.jpg> (accessed Jan. 10, 2008).

⁶⁶ “*TIME.*” 23 Apr. 1951. <http://www.time.com/printout/0,8816,821572,00.html> (accessed Nov. 9, 2007).

⁶⁷ Appendix 1.

⁶⁸ *United States Army Air Forces*, <http://en.wikipedia.org/wiki/USAAF> (accessed January, 2008)

⁶⁹ Appendix 1.

⁷⁰ Ibid.

⁷¹ “*TIME.*” 23 Apr. 1951. <http://www.time.com/printout/0,8816,821572,00.html> (accessed Nov. 9, 2007).

⁷² Appendix 1.

⁷³ Ibid.

⁷⁴ Ibid.

⁷⁵ Ibid.

⁷⁶ Ibid.

⁷⁷ Ibid.

⁷⁸ Ibid.

⁷⁹ Ibid.

⁸⁰ Ibid.

⁸¹ Ibid.

⁸² Ibid.

⁸³ Ibid.

⁸⁴ Ibid.

⁸⁵ Ibid.

⁸⁶ Roush, Gary. "Helicopter Losses During the Vietnam War." *Vietnam Helicopter Pilots Association*. Vietnam Helicopter Pilots Association. n.d. <http://www.vhpa.org> (accessed Nov. 10, 2007).

⁸⁷ Brush, Peter. "*THE HELICOPTER ROAD TO VIETNAM*." 1994. http://www.library.vanderbilt.edu/central/brush/Helicopters-Vietnam.htm#_edn12 (accessed Dec. 12, 2007).

⁸⁸ Roush, Gary. "Helicopter Losses During the Vietnam War." *Vietnam Helicopter Pilots Association*. Vietnam Helicopter Pilots Association. n.d. <http://www.vhpa.org> (accessed Nov. 10, 2007).

⁸⁹ Sloniker, Mike. "Lam Son 719 – 1971." *A/101 Aviation AHC/AHB/Regt, 101st Airborne Division, First and Finest*. A/101 Aviation AHC/AHB/Regt, 101st Airborne Division, First and Finest. n.d. <http://www.a101avn.org/LamSon719.html> (accessed Feb. 21, 2008).

⁹⁰ Roush, Gary. "Helicopter Losses During the Vietnam War." *Vietnam Helicopter Pilots Association*. Vietnam Helicopter Pilots Association. n.d. <http://www.vhpa.org> (accessed Nov. 10, 2007).

⁹¹ Employment in the Aircraft, Engines, and Parts Industry, Calendar Years 1983-1997, Aerospace Industries Association, http://www.aia-aerospace.org/stats/facts_figures/ff_98_99/ff98p139.pdf (accessed November, 2007)

⁹² Congressional Budget Office. *An Analysis of US Army Helicopter Programs*, 1995. Washington, DC: Congressional Budget Office, 1995, pp. 2.

⁹³ Ibid, pp. 64.

⁹⁴ Ibid, pp. 26.

⁹⁵ Ibid, pp. 26.

⁹⁶ Department of the Army G-8. *Helicopter Analysis*, 2007. Washington, DC: Department of the Army G-8, 2007.

⁹⁷ Total Employment, 1990 to date, Aerospace Industries Association, http://www.aia-aerospace.org/stats/aero_stats/stat12.pdf (accessed November, 2007)

⁹⁸ Department of the Army. *Aviation Attrition Replacement Deliveries*, 2007. Washington, DC: U.S Army G-4, 2007.

⁹⁹ Appendix 1.

¹⁰⁰ Roush, Gary. "Helicopter Losses During the Vietnam War." *Vietnam Helicopter Pilots Association*. Vietnam Helicopter Pilots Association. n.d. <http://www.vhpa.org> (accessed Nov. 10, 2007).

¹⁰¹ Department of the Army. *Aviation Attrition Replacement Deliveries*, 2007. Washington, DC: U.S Army G-4, 2007.

¹⁰² Appendix 1.

¹⁰³ Ibid.

¹⁰⁴ Department of the Army G-8. *Helicopter Analysis*, 2007. Washington, DC: Department of the Army G-8, 2007.

¹⁰⁵ Ibid.

¹⁰⁶ Department of the Army G-8. *ARFORGEN Equipment-Set_Reset and Modernization:_Potential Aviation Force Pool Needs*, 2007. Washington, DC: Department of the Army G-8, 2007.

¹⁰⁷ Ibid.

¹⁰⁸ Ibid.

¹⁰⁹ Ibid.

¹¹⁰ Ibid.

¹¹¹ Ibid.

¹¹² Department of the Army. *Aviation Attrition Replacement Deliveries*, 2007. Washington, DC: U.S Army G-4, 2007.